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G1F F1H
H4L LASS
U1S S1727

(56) Documents Cited

GB 2278196 A	GB 2271902 A	EP 0613021 A1
EP 0595685 A1	WO 97/38326 A1	WO 96/26579 A1
US 5523765 A	US 4510496 A	US 4283726 A

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INT CL[6] G01C , G01S

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(54) Abstract Title
Guidance system

(57) The navigational system, device and method of the present invention provide navigational information to the user 16 derived from data signals received from a plurality of first transmitter. The range to each of the plurality of first transmitters is then computed based upon the corresponding data signal received from the first transmitter, and a current position relative to each of said plurality of first transmitters is then determined. Geographical data relating to at least the current location of the receiver 20 is stored in a memory 28, and selected geographical data relating to the current location of the receiver 20 from is retrieved from the memory 28 to provide an audio or video display 32.

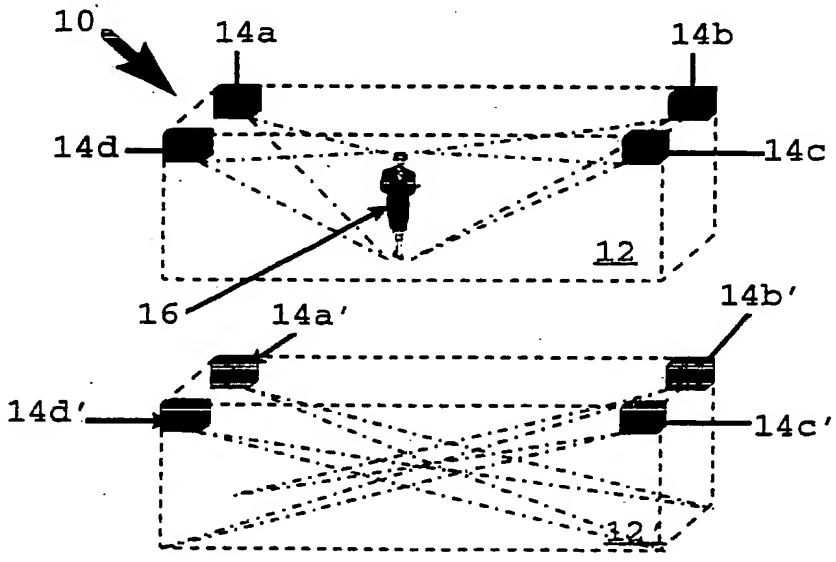

Figure 1

GB 2 326 550 A

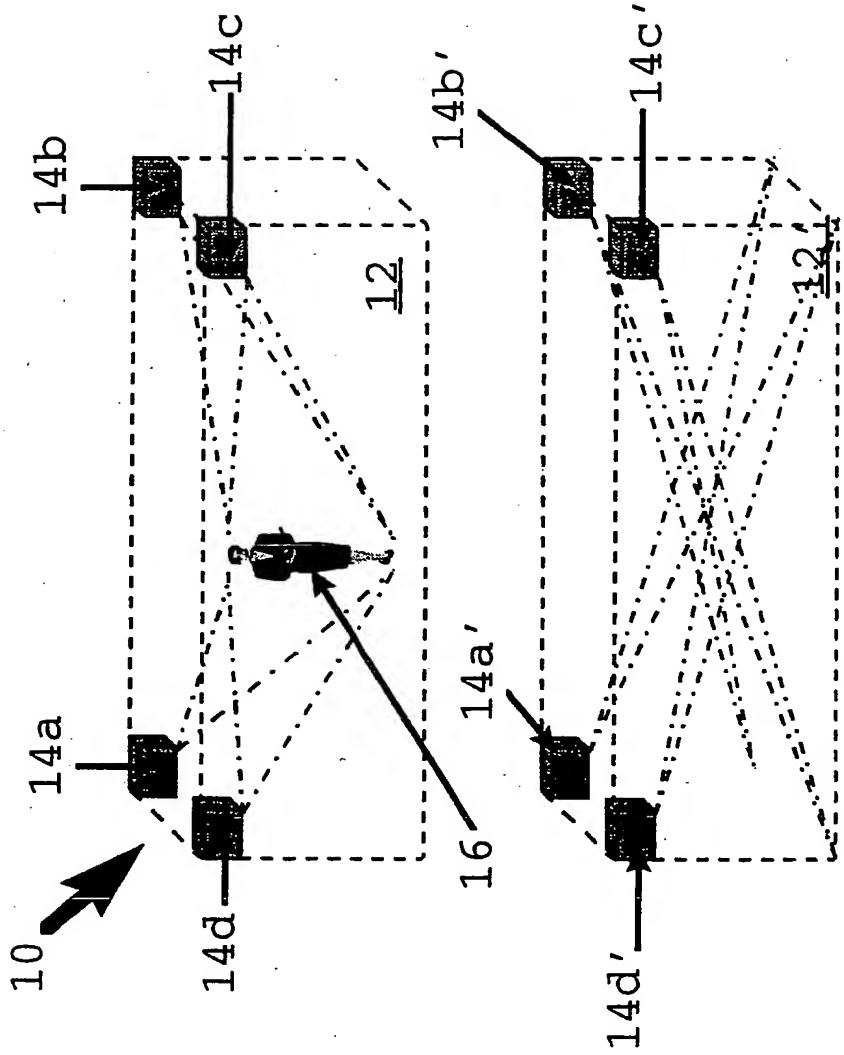

Figure 1

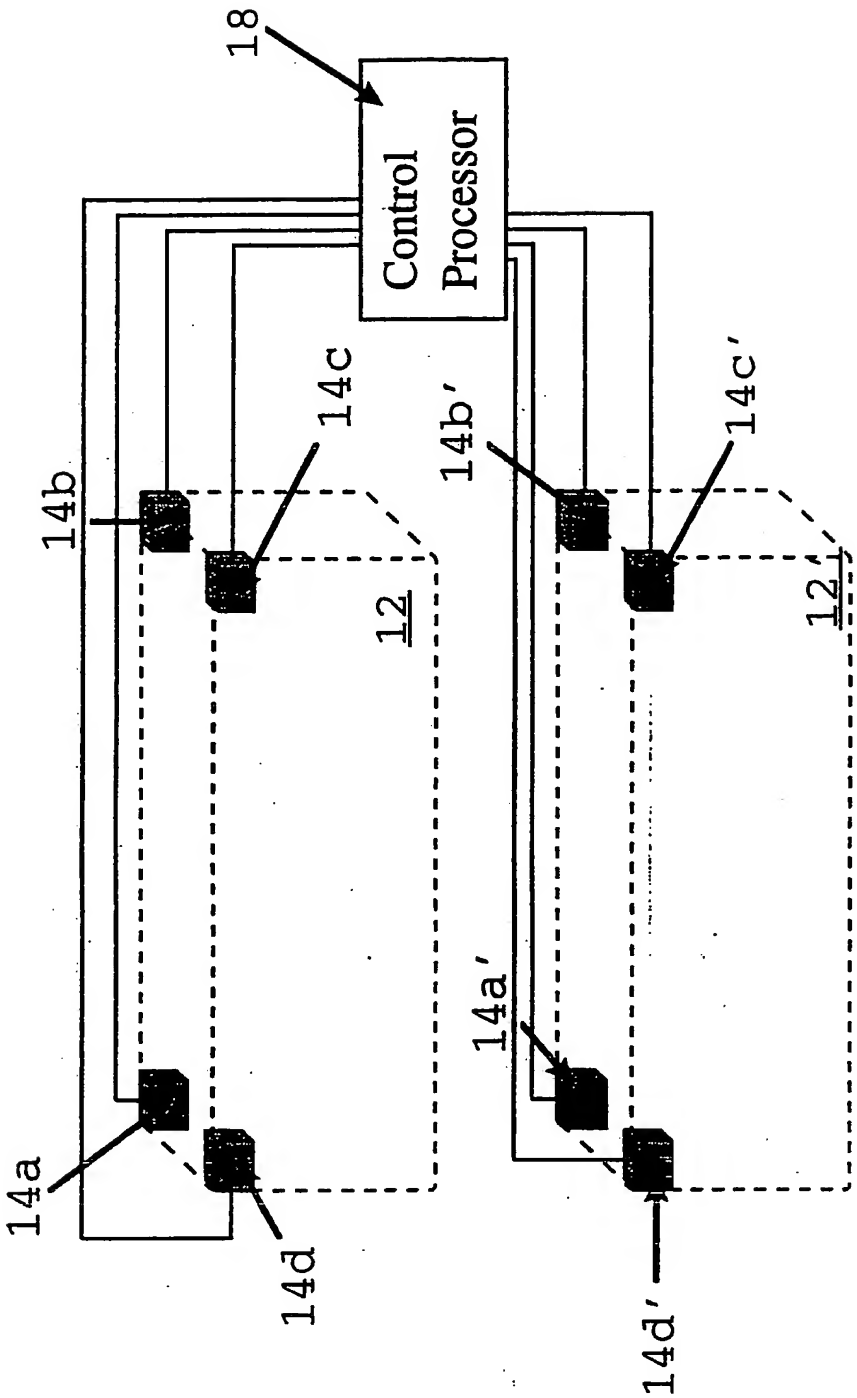

Figure 1a

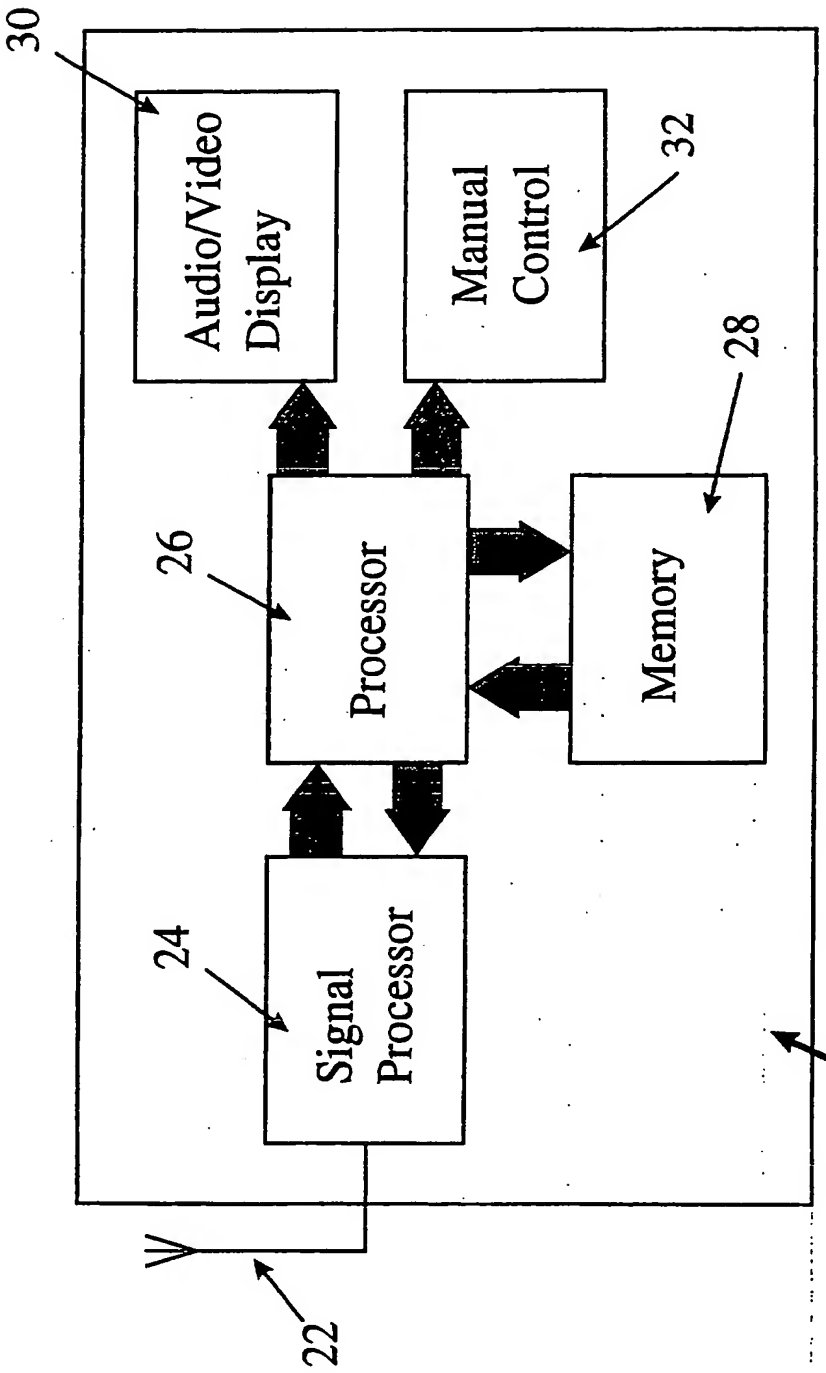
30
Audio/Video Display
Manual Control
32
28
26
Processor
Memory
24
Signal Processor
20
22

Figure 2

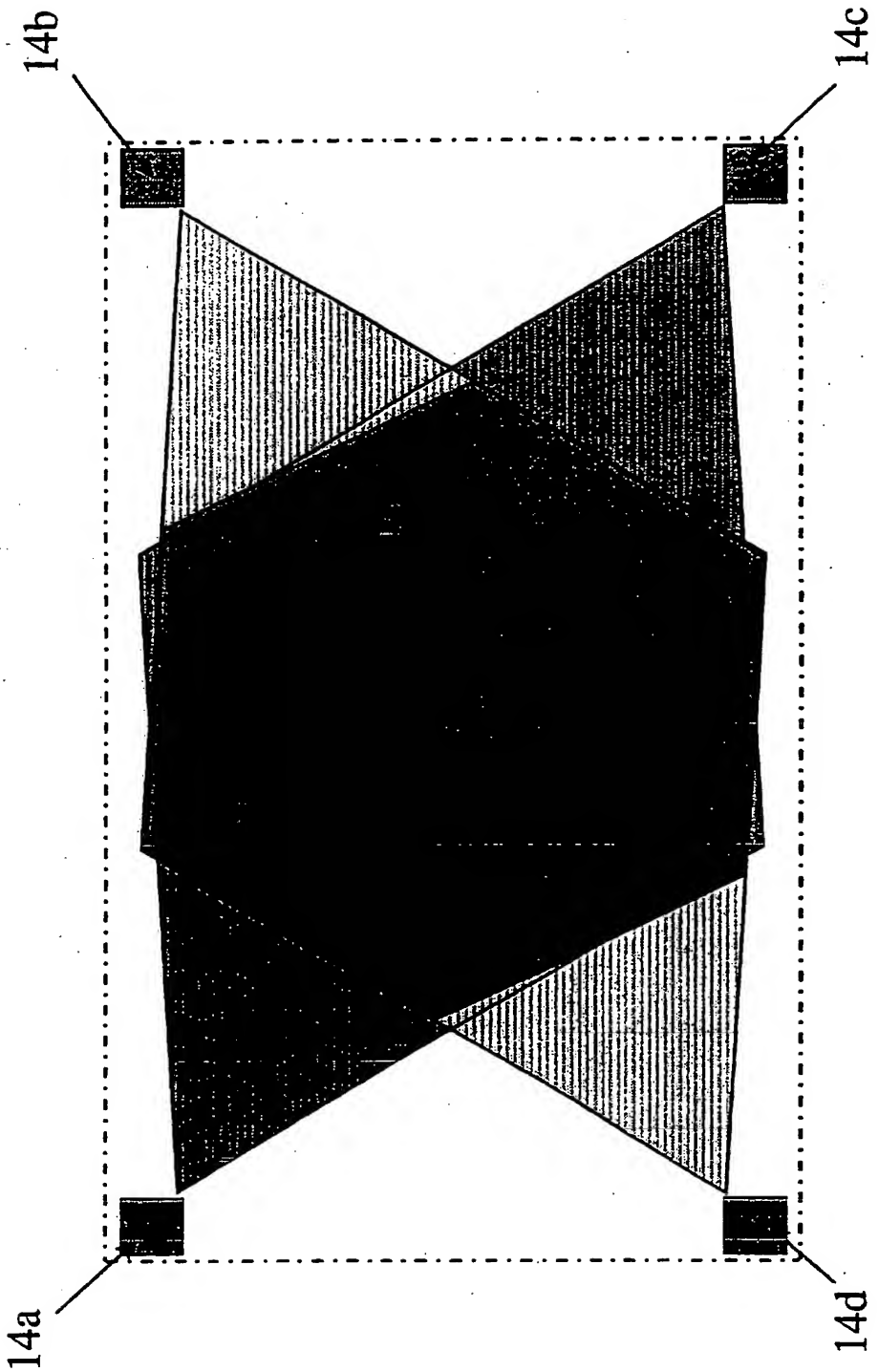

Figure 3

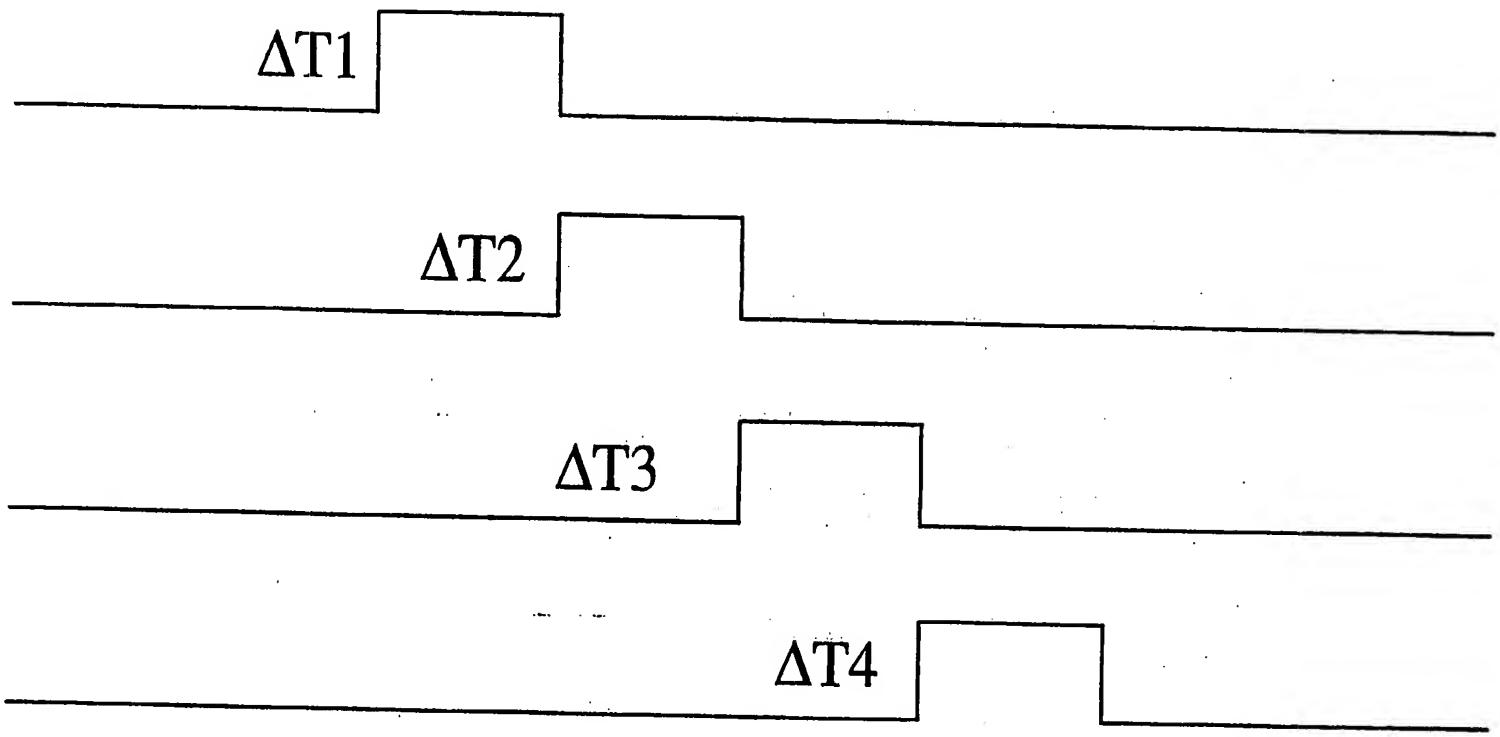

Figure 4

2326550

A NAVIGATIONAL SYSTEM

FIELD OF THE INVENTION

The present invention relates to the field of navigational systems, and more particularly to a system, device and method of operation that provides the user with current information on the immediate environment and a route to a selected destination.

BACKGROUND OF THE INVENTION

Systems for providing positional and navigational information are known in the art. Typically, these systems utilise signals derived from a Global Positioning System (GPS) such as the NAVSTAR system.

Navstar was developed to provide accurate position, velocity, and time information in any environmental conditions. The system includes twenty-four satellites arranged in six orbital planes such that the satellites orbit the planet in circular orbits with a twelve hour period. The satellite orbits are arranged such that at least four satellites are in "view" (i.e. not obscured by the curvature of the planet) from any position on the planet.

Each user module receives periodically transmitted signals from four satellites. The user unit computes a range to each satellite based upon the known time of receipt of the signal, and a predicted time of transmission of the signal from the satellite.

GPS systems commonly have two standards of operation; a military standard and a civilian standard. Systems operating according to the military standard provide a positional accuracy of 16 metres, a velocity accuracy of 0.1 metres per second, and a time accuracy to 100

nanoseconds. However, the signals transmitted by the satellites according to the military standard are encrypted to prevent unauthorised access. Comparably, systems operating according to the civilian standard provide a positional accuracy of 100 metres.

Vehicle navigational systems are well known in the art. For example, European Patent Application No. EP-A-0,542,331 discloses a vehicle navigational device for directing a vehicle along a predetermined route. The device utilises GPS positional data displayed on a display unit within the vehicle

A further navigational device which includes a GPS receiver is disclosed in issued United States Patent No. 5,270,936. The device receives co-ordinates of the current position from received GPS signals. A reference point adjacent the current position is retrieved from a recording medium coupled to the device. The distance and direction to the reference point is then calculated and the direction, distance and an identifier are displayed for the user. However, this device requires a recording medium to be coupled that contains data relevant to the immediate environment for providing directional instructions to the user.

A hand-held guidance device is disclosed in United Kingdom Patent Application No. GB 2,298,539 which utilises a GPS receiver, a radio triangulation position sensor, and a compass. The device displays a map of the immediate environment, and the position of the user relative to selected reference points within the immediate area. However, the map and other data relevant to the immediate environment must be downloaded from a removable cartridge which contains data only relevant to a predetermined area.

From the teachings of each of the cited prior art documents it will be noted by those skilled in the art that each navigational device requires additional data storage elements containing stored data relevant to the current environment of the user.

SUMMARY OF THE INVENTION

Therefore, a need exists for a navigational device in which relevant data is automatically downloaded that is relevant to the immediate environment of the user. Such a device will have the advantage of reduced cost (since no additional data storage elements are required), convenience of use, and reliability.

Accordingly the present invention provides a system, device, and method for providing navigational information to a user that is interpreted in the context of local environmental information. A user utilising the device of the invention in a shopping mall having several floors each containing retail outlets, will be able to select a route to a desired store based upon input information. For example should the user wish be provided with a route to a clothing store within the mall, but also wish to visit a shoe store an appropriate route will be provided in which the user may be directed to the desired clothing store via a number of shoe stores.

Therefore, according to a first aspect of the present invention there is provided a navigational system comprising; a receiver for receiving data signals from a plurality of first transmitters; a processor for computing the range to each of the plurality of first transmitters based upon the corresponding data signal received therefrom, and for determining a current position relative to each of said plurality of first

transmitters; a memory for storing geographical data relating to at least the current location of the receiver; means for selecting geographical data relating to the current location of the receiver; and a display for providing an audio or video display of the selected geographical data.

In the preferred embodiment of the present invention the plurality of first transmitters are local transmitters having a limited transmission range. Typically, the first transmitters are disposed on each level of a building structure.

The transmitted data signals preferably comprise a geographical data component providing information on the current environment, and a positional data component the processor with information necessary to determine the instantaneous position of the receiver. For example, the geographical data may comprise a map of the current location or details of places of interest.

Preferably, the second transmitter polls one of the first transmitters, and receives geographical data relevant to the instantaneous environment of the receiver from the first transmitter in response to being polled. The received geographical data is then stored in the memory.

Preferably geographical data can be provided to the memory for storage by coupling the receiver to an external device. The external device may comprise a computer linked to a database via a network or modem, or comprise a CD-ROM, floppy disk or other suitable data storage medium.

The user is provided with a keyboard or other suitable data entry device for selecting a route between the

current location and a destination location. A first reference point is assigned to the current location and a second reference point is assigned to the destination location. Further locations between said current location and said destination location may be selected and are assigned reference points accordingly.

According to a second aspect of the present invention there is provided a user module for a navigational system comprising; a receiver for receiving data signals from a plurality of first transmitters; a processor for computing the range to each of the plurality of first transmitters based upon the corresponding data signal received therefrom, and for determining a current position relative to each of said plurality of first transmitters; a memory for storing geographical data relating to at least the current location of the receiver; means for selecting geographical data relating to the current location of the receiver; and a display for providing an audio or video display of the selected geographical data.

Preferably, the user module is hand-held or comprises a head-up display. Alternatively the user module may comprise a portable computing device. The display generally comprises an image of the current environment and a display of a navigational indication element.

According to a third aspect of the present invention there is provided a method of providing navigational information comprising; receiving data signals from a plurality of first transmitters; computing the range to each of the plurality of first transmitters based upon the corresponding data signal received therefrom, and for determining a current position relative to each of said plurality of first transmitters; storing geographical

data relating to at least the current location of the receiver in a memory; selecting geographical data relating to the current location of the receiver from said memory; and providing an audio or video display of the selected geographical data.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will now be further described, by way of example, with reference to the accompanying drawings in which:

Figure 1 shows an exploded block illustration of two levels of a building including a navigational system according to the present invention;

Figure 1a shows an exploded block illustration of two levels of a building equipped with the navigational device of the invention having a central control processor;

Figure 2 shows a schematic block illustration of the user module of the navigational system of Figure 1 or Figure 1a;

Figure 3 shows a schematic plan view of a floor of the building of Figure 1 or Figure 1a; and

Figure 4 shows a timing diagram of the navigational system of Figure 1 or Figure 1a.

For convenience like and corresponding features of the accompanying drawings have been assigned corresponding reference numerals.

DETAILED DESCRIPTION OF THE DRAWINGS

For convenience the present invention will be described in terms of a navigational system installed within a building structure. However, it will be appreciated by a skilled person that the system, method and device of the present invention may equally well be implemented within other structures, or to cover larger areas and environments.

Referring to Figure 1, there is shown an exploded block schematic illustration of the system of the present invention. A building structure 10 having a plurality of floors 12, 12' is shown, although it should be understood that the present invention may be implemented in a single storey building. A plurality of transponders (14a-d, 14a'-d') are disposed at positions around each floor (12, 12'). Each transponder (14a-d, 14a'-d') periodically transmits a clock signal (CLK) over a limited and predetermined range.

Referring now to Figure 1a, there is illustrated an exploded view of a block schematic diagram of the navigational system of the present invention. The system includes transponders (14a-d, 14a'-d') each located on a wall of a respective one of the floors (12, 12') of a building 10. For convenience only four transponders (14a-d, 14a'-d') are illustrated on each floor (12, 12'). In practise sufficient transponders will be provided to ensure that it is possible to receive a signal from at least four transponders (14a-d, 14a-d') from any position within the area of each floor (12, 12'). Each transponder is capable of data communication with a control processor 18 associated with the building 10.

Preferably the control processor 18 is in the form of a database that contains information pertaining to the building environment. For example, when the system is

utilised within a shopping mall the database may include data relating to the type of stores within the building, to products stocked in each store, to discounted or sale products within each store, and to the opening times of each store. Alternatively, the system may be utilised within a museum or other building and the database may include data relating to exhibits within the museum, to the location of exhibits within the building, and to geographical or historical information relating to the building and/or exhibit.

Referring now to Figure 2, there is illustrated a block schematic illustration of a user module 20 for use with the system 10 of the invention. The user module 20 includes an antennae 22, signal processor 24, microprocessor 26, memory 28, audio/video display 30, and manual control unit 32. The signal processor 24 and microprocessor 26 may be provided in the form of a unitary device such as a digital signal processor. For example, a suitable digital signal processor would be TMS320C6X manufactured by Texas Instruments Inc.

Operation of the system 10 for determining the position of the user will now be described with reference to Figures 1a, 3 and 4.

Each transponder (14a-d, 14a-d') periodically transmits a clocking signal (CLK_1-CLK_4) which is received by the antennae 22 of user module 20 if the user module 20 is within the transmission window of the transponder (14a-d, 14a-d'). For example, a user 16 equipped with a user module 20 located within the region 21 of Figure 3 is within the transmission window of each of transponders (14a-d, 14a-d') and can therefore receive each of the clocking signals (CLK_1-CLK_4) associated therewith.

The clocking signals (CLK_1-CLK_4) are illustrated in Figure 4. The respective transponders (14a-d, 14a-d') are arranged to transmit the clocking signals (CLK_1-CLK_4) sequentially so that no two signals are transmitted during the same period.

The processor 26 of the user module 26 calculates the position of the user 16 within the area of the floor 12 by calculating the transmission period of each of the four clocking signals (CLK_1-CLK_4). From the calculation of the transmission period of each clocking signal the processor is able to calculate the position of the user 16 relative to each of the four transponders (14a-d, 14a-d').

The following four equations are constructed and solved to calculate the range to each transponder (14a-d, 14a-d') in two-dimensions;

$$(X_1 - U_x)^2 + (Y_1 - U_y)^2 = (R_1 - C_H)^2 \qquad \text{(i)}$$

$$(X_2 - U_x)^2 + (Y_2 - U_y)^2 = (R_2 - C_H)^2 \qquad \text{(ii)}$$

$$(X_3 - U_x)^2 + (Y_3 - U_y)^2 = (R_3 - C_H)^2 \qquad \text{(iii)}$$

$$(X_4 - U_x)^2 + (Y_4 - U_y)^2 = (R_4 - C_H)^2 \qquad \text{(iv)}$$

where $R_1 = C \times \Delta T_1$, $R_2 = C \times \Delta T_2$, $R_3 = C \times \Delta T_3$, $R_4 = C \times \Delta T_4$, and C is the speed of light (2.997925×10^8 ms^{-1}).

Once the position of the user 16 relative to four transponders (14a-d, 14a-d') has been determined, the user module 20 polls the nearest transponder (14a-d, 14a-d') which interrogates the control processor 18 for data relating the instantaneous environment of the user 16.

For example, on entering a shopping mall the user module 20 first determines the position of the user 16 relative the four closest transponders (14a-d, 14a-d'). The transponder then polls the nearest of the four transponders (14a-d, 14a-d') for generic information relating to the shopping mall (e.g. types of stores, opening times etc.). The transponder (14a-d, 14a-d') interrogates the control processor 18 for data relating to this generic information and transmits the data back to the user module 20.

The data from the transponder (14a-d, 14a-d') is received at antennae 22 and passed to signal processor 24. The signal processor may decompress, decrypt, filter and quantize the signal before it is passed to processor 26. The processor 26 then stores the received data in memory 28. The processor 26 then selects the data relating to generic information about the shopping mall and provides the information to audio visual display 30 in the form of a menu.

The user 16 then selects information of interest from the menu by actuating manual control 32. The processor 26 is responsive to actuation of the manual control 32, and selects data corresponding to a user query entered via actuation of the manual control 32. For example, it is envisaged that a menu be provide which details environmental information relating to facilities within the building 10 or floor 12. Generic information can also be provided so that the user 16 may select a user query for polling the transponder for information relating thereto. The manual control 32 typically comprises a keypad or other data entry device.

For example, the menu may provide generic details of stores within a shopping mall. A user wishing to select a shoe store will select the menu entry relating to shoe stores, and a user query will be transmitted to the nearest transponder (14a-d, 14a-d'). The transponder will then request that data relating to the user query be provided from the database stored in control processor 18. Consequently, data relating to the user query will be provided to transponder (14a-d, 14a-d') which will be transmitted to the user module 20.

Initially, data will be provided which provides geographical information, and detailed information of the individual shoe stores for display in a sub-menu. The user may then select a shoe store from the sub-menu and the user module 20 will again poll the transponder to request information relating to the selected shoe store and its location within the building 10. Alternatively, the user 16 may request directions to the nearest shoe store.

The processor 26 will then determine the position of the user 16 as discussed previously, and calculate the position of the selected shoe store in relation to the user 16. Where the user 16 has selected a shoe store that is not the nearest, the processor must compute a route thereto. The route is computed by first determining the position of the shoe store in relation to the user. For example, if the shoe store is not on the floor 12 on which the user is currently situated, the processor firstly computes a route to stairs or an elevator.

For convenience, intermediate locations between the current location of the user 16 and the destination of

the user 16 will be hereinafter referred to as way-points.

The processor 26 will then provide directions to the first way-point from the current location of the user 16. Once the first way-point is reached the process of polling and receiving information relating to the instantaneous environment from the control processor 18 is repeated for determining subsequent way-points.

Within a building 10 or floor 12 having a large area data may be received from the control processor 18 which is only relevant to the immediately adjacent area. Preferably, the received data/environmental information is in the form of a map of the floor 12.

As the user 16 travels between the way-points the user module continuously receives and updates the position and/or geographical information that is stored in memory and that is provided to audio/video display 30. Preferably the generated display image shows the position of the user 16 in relation to a map of the immediate environment.

It is envisaged that, in use, a user 16 may wish to be provided with a route to a selected destination via one or more intermediate locations. The processor 26 is provided with software for determining a route to the destination via a plurality of way-points, the route being determined according to the preferences entered by the user 16 on manual control 32.

In a preferred embodiment a directional indication to subsequent way-points is provided by the display to direct the user from the initial position via a sequence

of intermediate way-points to the destination (i.e. the selected shoe store).

Although the invention has been described in terms of a system having transponders (14a-d, 14a'-d') disposed on each floor of a building 10, it will be apparent to the skilled person that the invention may be effected with as few as four transponders (14a-d, 14a'-d'). The position of the user 16 relative to the transponders (14a-d, 14a'-d') may be calculated in terms of longitude, latitude, and altitude co-ordinates and data relating to the immediate environment of the user 16 can be selected from the control processor accordingly.

The processor 26 of the user module 26 calculates the position of the user 16 within the area of the floor 12 by calculating the transmission period of each of the four clocking signals (CLK_1-CLK_4). From the calculation of the transmission period of each clocking signal the processor is able to calculate the position of the user 16 relative to each of the four transponders (14a-d, 14a-d').

The following four equations are constructed and solved to calculate the range to each transponder (14a-d, 14a-d') in three-dimensions;

$$(X_1 - U_x)^2 + (Y_1 - U_y)^2 + (Z_1 - U_z)^2 = (R_1 - C_H)^2 \qquad (i)$$

$$(X_2 - U_x)^2 + (Y_2 - U_y)^2 + (Z_2 - U_z)^2 = (R_2 - C_H)^2 \qquad (ii)$$

$$(X_3 - U_x)^2 + (Y_3 - U_y)^2 + (Z_3 - U_z)^2 = (R_3 - C_H)^2 \qquad (iii)$$

$$(X_4 - U_x)^2 + (Y_4 - U_y)^2 + (Z_4 - U_z)^2 = (R_4 - C_H)^2 \qquad (iv)$$

where $R_1 = C \times \Delta T_1$, $R_2 = C \times \Delta T_2$, $R_3 = C \times \Delta T_3$, $R_4 = C \times \Delta T_4$, and C is the speed of light (2.997925×10^8 ms^{-1}).

Although the present invention has been described in terms of a navigational system for a shopping mall it will be apparent to those skilled in the art that the invention is capable of application within any building. For example, the invention may be implemented in historical buildings, museums or art galleries for providing a user 16 with information relating to the building and to artefacts or exhibits housed therein. It is further envisaged that the invention may be utilised by the emergency services when entering a unfamiliar building to effect a rescue.

Since the present invention merely requires the provision of a plurality of transponders disposed such that a user module 12 located within an area can receive information from at least four of the transponders, it will further be apparent to the skilled person that the invention may be implemented over wider areas such as towns, streets etc.

It is further envisaged that control modules 18 associated with, for example, a building may be linked for data communication with a network of corresponding control modules located in, for example further buildings in a street or area.

It is further envisaged that advertising material, together with other general information may also be downloaded to the user module 12 for provision on the audio/video display 30. It is yet further envisaged that data may be provided for provision of an audio or video display 30 in a language selected by the user 16. It is yet further envisaged that items may be provided with

actuable transmitters in order that stolen items can be located and tracked within a predefined area. It is yet further envisaged that children entering the predefined area may be provided with actuable transmitters for locating missing children within the predefined area.

Preferably, the display is provided in the form of an LCD or other suitable video display device. However, the display may be provided in the form of glasses, goggles or visor having a head-up display capability.

WHAT IS CLAIMED IS:

1. A navigational system comprising;

a receiver for receiving data signals from a plurality of first transmitters;

a processor for computing the range to each of the plurality of first transmitters based upon the corresponding data signal received therefrom, and for determining a current position relative to each of said plurality of first transmitters;

a memory for storing geographical data relating to at least the current location of the receiver;

means for selecting geographical data relating to the current location of the receiver; and

a display for providing an audio or video display of the selected geographical data.

2. The navigational system as claimed in Claim 1, wherein the plurality of first transmitters are local transmitters.

3. The navigational system as claimed in Claim 1 or Claim 2, wherein the first transmitters are disposed within a building structure.

4. The navigational system as claimed in Claim 3, wherein a plurality of first transmitters are disposed on each level of the building structure.

5. The navigational system as claimed in Claim 3 or Claim 4, wherein each of the first transmitters are arranged for transmitting data signals over a predetermined range.

6. The navigational system as claimed in any preceding claim, wherein the data signals comprise a geographical data component and a positional data component.

7. The navigational system as claimed in any preceding claim further comprising;

a second transmitter for polling at least one of said plurality of first transmitters, for receiving geographical data from the first transmitter in response thereto, and for storing received geographical data in said memory.

8. The navigational system as claimed in any of Claims 1 to 7 further comprising;

coupling means for coupling said receiver to an external device and for receiving geographical data therefrom.

9. The navigational system as claimed in any preceding further comprising;

selection means for selecting a route between a current location and a destination location, said means assigning at least a first reference point to said current location and a second reference point to said destination location.

10. The navigational system as claimed in Claim 9 further, wherein the selection means is further arranged for selecting further locations between said current location and said destination location and for assigning reference points to said further locations.

11. A navigational system substantially as claimed herein with reference to any of the accompanying drawings.

12. A user module for a navigational system comprising;

a receiver for receiving data signals from a plurality of first transmitters;

a processor for computing the range to each of the plurality of first transmitters based upon the corresponding data signal received therefrom, and for determining a current position relative to each of said plurality of first transmitters;

a memory for storing geographical data relating to at least the current location of the receiver;

means for selecting geographical data relating to the current location of the receiver; and

a display for providing an audio or video display of the selected geographical data.

13. The user module as claimed in Claim 12, wherein the data signals comprise a geographical data component and a positional data component.

14. The user module as claimed in Claim 12 or Claim 13 further comprising;

a second transmitter for polling at least one of said plurality of first transmitters, for receiving geographical data from the first transmitter in response thereto, and for storing received geographical data in said memory.

15. The user module as claimed in any of Claims 12 to 14 further comprising;

coupling means for coupling said receiver to an external device and for receiving geographical data therefrom.

16. The user module as claimed in any preceding further comprising;

selection means for selecting a route between a current location and a destination location, said means assigning at least a first reference point to said current location and a second reference point to said destination location.

17. The user module as claimed in Claim 16, wherein the selection means is further arranged for selecting further locations between said current location and said destination location and for assigning reference points to said further locations.

18. The user module as claimed in any of Claims 12 to 17, wherein the user module is hand-held.

19. The user module as claimed in any of Claims 12 to 17, wherein the user module comprises a portable computing device.

20. The user module as claimed in any of Claims 12 to 19, wherein the display comprises a head-up display.

21. The user module as claimed in any of Claims 12 to 20, wherein the display comprises an image of the current environment and a display of a navigational indication element.

22. A user module substantially as claimed herein with reference to any of the accompanying drawings.

23. A method of providing navigational information comprising;

receiving data signals from a plurality of first transmitters;

computing the range to each of the plurality of first transmitters based upon the corresponding data

signal received therefrom, and for determining a current position relative to each of said plurality of first transmitters;

storing geographical data relating to at least the current location of the receiver in a memory;

selecting geographical data relating to the current location of the receiver from said memory; and

providing an audio or video display of the selected geographical data.

24. The method as claimed in Claim 23 further comprising; disposing the first transmitters within a building structure.

25. The method as claimed in Claim 24 further comprising; disposing a plurality of first transmitters on each level of the building structure.

26. The method as claimed in Claim 24 or Claim 25 wherein the step of disposing the first transmitters comprises providing first transmitters that are arranged for transmitting data signals over a predetermined range.

27. The method as claimed in any of Claims 23 to 26 further comprising providing data signals comprising a geographical data component and a positional data component.

28. The method as claimed in any of Claims 23 to 27 further comprising;

polling at least one of said plurality of first transmitters, receiving geographical data from the first transmitter in response thereto, and storing received geographical data in said memory.

29. The method as claimed in any of Claims 23 to 28 further comprising;

coupling said receiver to an external device and receiving geographical data therefrom.

30. The method as claimed in any of Claims 23 to 29 further comprising;

selecting a route between a current location and a destination location; and

assigning at least a first reference point to said current location and a second reference point to said destination location.

31. The method as claimed in Claim 30 further comprising providing selecting further locations between said current location and said destination location and assigning reference points to said further locations.

32. A method of providing navigational information substantially as claimed herein with reference to any of the accompanying drawings.

The Patent Office

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Application No: GB 9712070.3
Claims searched: 2-5,24-26

Examiner: Dr E P Plummer
Date of search: 22 October 1998

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.P): H4D (DAB, DPBA, DPBC, DPBX, DSDX); G1F (F1H)

Int Cl (Ed.6): G01S, G01C

Other:

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
Y	GB2278196A	Taylor whole document	2
Y	GB2271902A	Caterpillar eg page 8 lines 17 to 23	2
X	EP0613021A1	FRANCE TELECOM whole document; nb figure 8, page 14 lines 48 to 51 and page 15 lines 22 to 25	2
Y	EP0595685A1	RENAULT whole document	2
A	WO97/38326A1	DISCOVISION	
Y	WO96/26579A1	STANFORD TELECOMMUNICATIONS eg abstract	2
Y	US5523765	ALPINE ELECTRONICS whole document	2
Y	US4510496	SPERRY whole document	2

X Document indicating lack of novelty or inventive step
Y Document indicating lack of inventive step if combined with one or more other documents of same category.
& Member of the same patent family

A Document indicating technological background and/or state of the art.
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The Patent Office

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Claims searched: 2-5,24-26

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Date of search: 22 October 1998

Category	Identity of document and relevant passage		Relevant to claims
Y	US4283726	SPENCE whole document	2

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
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